PROXIMATE COMPOSITION OF COMPLEMENTARY FOOD MADE FROM MULTI-MIXES OF SORGHUM, MILLET, CRAYFISH, SOYBEAN AND GINGER FOR INFANT NUTRITION

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Abstract

This study determined the proximate composition of complementary food made from malted sorghum, malted millet, crayfish, soybean and ginger blends. The composite blends were formulated in different ratios. Sample A - 50% soybean, 30% millet, 20% sorghum, Sample B - 20% soybean, 25% millet, 40% sorghum, 10% crayfish, 5% ginger, Sample C - 40% soybean, 20% millet, 25% sorghum, 10% crayfish, 5% ginger, Sample D - 25% soybean, 40% millet, 20% sorghum, 10% crayfish, 5% ginger and Sample E - 15% soybean, 20% millet, 50% sorghum, 10% crayfish, 5% ginger respectively. The result revealed that, moisture, protein, fat, fibre, ash and carbohydrate content values ranged from 8.58 to 10.19%, 9.58 to17.12%, 1.08 to 3. 2.87%, 4.11 to 6.83%, 2.19 to 3.62% and 60.99 to 72.54% respectively. Moreover, the results revealed that the complementary food samples contained considerable amount of protein, fibre, ash and carbohydrate needed by the body for well being of infant and children.. In addition, this study found out that complementary food sample E contain significant amount of essential nutrients compared to other samples. This study concluded that complementary foods could be produced from multi- mixes for households who depend on locally formulated diets to feed infant and young ones. This study therefore recommend use of sorghum, millet , soybean and crayfish that are high in protein and other essential nutrient to meet the nutritional needs of infants and young children as it could be a panacea to promote dietary diversity and reduce prevalence of under-five malnutrition in Nigeria.

Keywords: Complementary foods, Food fortification, Infant nutrition

Introduction

Nutritional requirements are highest during infancy, a time of rapid physical development and the maturation of physiological, immunological, and cerebral skills. Protein, cholesterol, zinc, and vital fatty acids are particularly important during the first two years of life, when crucial brain development takes place Barker D J (2004). However, malnutrition persists and is pervasive in a number of developing countries despite the availability of copious food supplies and alternatives. (Onoja & Obizoba, 2009)

Micronutrient deficits and protein energy malnutrition (PEM) in babies, children, and pregnant women have been linked to a high burden of pediatric illness and death in low- and middle-income countries. While estimates of malnutrition's contribution to these communities' high illness and death rates vary, they are generally accepted to be in the high single digits.

Breast milk alone may not be sufficient to supply the nutritional demands of a growing and active newborn beyond the first six months of life. As they age, the nutritional difference widens more (Abeshu, et al., 2016). When breast milk alone is not enough to fulfill the nutritional needs of a newborn or young kid, complementary meals are provided after the exclusive breastfeeding phase has ended (Kleinman, 2004). In Nigeria, the traditional complementary foods consist mainly of porridges made from maize which may not adequately meet the energy and nutrient requirements of infants (Onoja & Obizoba, 2009)

However, there is a growing demand for inexpensive supplemental food alternatives like those made from a blend of sorghum, millet, soybeans, crayfish, and ginger. These foods are simple enough to make at home or in a shared kitchen, and the necessary processing equipment is widely accessible in underdeveloped countries. These multi-mixes provide an inexpensive way to meet nutritional needs by making use of readily accessible food crops in the area. In certain cases, they may even be more nutrient-dense than popular supermarket brands.

The cereal grain sorghum, or *Sorghum bicolor (L.) Moench* according to its technical name is the fifth most widely produced cereal crop in the world after wheat, rice, maize, and barley (FAO, 2012). The vital elements phosphorus, magnesium, calcium, and iron are all found in abundance in this highly prized grain and Lysine is the most important and scarce amino acid in sorghum, making it similar to wheat and maize in this regard (Elemo & Okafor, 2011).

Millet, or *Pennisetum glaucum*, is a member of the grass family **(Poaceae)** and the subfamily *(Paniceae).* It is a kind of cereal that is grown all over the world for human use. Grain security is greatly improved by the use of pearl millet as a staple grain in semi-arid parts of the developing world (FAO, 2010).

Nutritionally, millet grains are at par with and even outshine some of the most popular cereals. One can get a lot of protein, carbs, fat, and even some vitamins and minerals out of them. Millet grains have more of the important amino acids methionine and cysteine than other cereals like rice and wheat Onabanjo et al., (2009).They also include a lot of fiber, which helps with digestion and promote healthy gut. Natural molecules called phytochemicals may be found in millets, and they serve as antioxidants and reduce inflammation. The health advantages of millet are in part due to these chemicals Onabanjo et al., (2009).

. Millets are often regarded as a healthy and useful dietary option, especially in regions with limited access to other main crops. Food insecurity may be alleviated and a more varied and healthy diet can be provided via their production and consumption.

However, crayfish is recognized as a cheap source of animal protein. Water, protein, and fat make up the bulk of fish's nutritional profile; carbohydrates, amino acids, and other nitrogenous compounds, as well as a variety of minerals and vitamins, are present in much smaller amount Salem et al., (2009).

According to the Encyclopedia (2018), soybeans (*Glycine max L.)* are an annual herbaceous legume plant in the *Papilionoidea* subfamily of the *Leguminosae* family. The oil content, which ranges from 17% to 25%, and the protein level, which ranges from 35% to 45%, makes it a rich resource. Soybeans are also a good source of vitamins B1 and B2. Omueti et al., (2009). Soybean protein, in particular, boasts an exceptional harmony of amino acids, exceeding that of other regularly farmed plants and coming quite near to Food and Agriculture Organization nutritional guidelines. FAO (2010).

Zingiber officinale is the scientific name for ginger, and it is a perennial plant of the *Zingiberaceae* family. The rhizomes that grow underground are the most important and beneficial elements of the plant. Since these rhizomes are both fragrant and pungent, they are often used in culinary applications (Kizhakkayil & Sasikumar, 2011). Water makes up around 79% of ginger's makeup among its many other components. Carbohydrates account for around 18% of the total, while protein and fat make up 2% and 1%, respectively. (Kizhakkayil & Sasikumar, 2011). Ginger has a relatively low calorie count, clocking in at about 80 per 100 grams. Edeoga et al., (2003) underlined the fact that ginger includes modest levels of key dietary elements such vitamin B6, magnesium, and manganese.

Ginger may help in the development of complementary meals that give a wide variety of nutritional advantages when paired with sorghum, millet, soybean, and crayfish. Due to their convenience, they may be easily prepared at home using readily accessible food crops. The processing methods used are straightforward, making them accessible even to non-technical members of the public; this is especially true in developing nations.

In addition to helping kids recover from malnutrition, these foods may fulfill their supplementary nutritional needs. A research by Barber et al., (2017) confirms the usefulness of these dietary combinations in combating childhood malnutrition and fostering recovery.

Materials and Method

Materials

Sayedero market in Ilaro, Ogun state, Nigeria provided the soya beans, sorghum, crayfish, ginger, and millet grain utilized in this investigation.

Sample Preparation of Malted-Sorghum and Malted-Millet Flour

Following the procedure described by (Bolarinwa et al., 2015), both malted sorghum and malted millet flour were made. In the first step, 2 kg of sorghum grains and millet grains were thoroughly examined for stones, debris, and other undesirable componets. The grains were then washed again, this time in cold water, and let to soak for 12 hours. The purpose of this procedure was to increase the grains' moisture content. After that, the grains was let for four days to start sprouting. The germinated seeds were dried in a cabinet drier at 60 °C until their moisture content was between 10 and 12 percent. Malted grains were dried, milled, sieved, and then packaged in seal lock cellophane bags to maintain freshness and quality until they were needed.

Sorghum grain
↓
Cleaning
↓
Soaking
↓
Draining
↓
Germination
↓
Drying (60^0 C for 30-40minutes)
↓
Milling
↓
Malted-sorghum flour

Fig. 1: Flowchart for the production of Malted-Sorghum Flour

Millet grain
↓
Cleaning
↓
Soaking
↓
Draining
↓
Germination
↓
Drying (60^0 C for 30-40minutes)
↓
Milling
↓
Malted-Millet flour

Fig. 2: Flowchart for the production of Malted-Millet Flour

Production Of Soybean into Soybean Flour

One kilogram (1kg) of soybean grains underwent a meticulous sorting process to remove any stones, rotten grains, and other physical defects. The remaining defect-free beans were thoroughly cleaned and soaked for duration of three hours. Subsequently, they were dehulled and boiled for fifteen minutes.

The production of soybean flour followed a modified version of the method described by Omueti et al., in (2009). The soybean grains were subjected to oven drying at a temperature of 60°C for duration of 15 minutes. Afterward, they were milled into a fine powder and sifted through a sieve to obtain a smooth flour texture. The resulting flour was then carefully packaged and sealed in sterile polyethylene bags to maintain its quality for further analysis.

Soybean
↓
Cleaning
↓
Soaking (overnight)
↓
Decanting (water)
↓
Boiling (30 minutes)
↓
Removal of seed coats
↓
Washing
↓
Draining
↓
Drying (oven) at 60^0 - 65^0 c
↓
Milling
↓
Cooling
↓
Packaging

Figure 3: Flowchart for the Production of Soybean Flour

Production of Crayfish Flour

One kilogram (1kg) of dried crayfish was carefully sorted to remove any dirt, stones, undesirable particles, and hard bones. The crawfish was then dry-milled to get a uniformly fine consistency. Milled crayfish was sieved through a 75-micron mesh to remove any remaining big pieces, resulting in a fine flour. After the crayfish flour had been milled and sieved, it was placed in clean, airtight plastic bags. This action was made so that the flour could continue to be processed without losing any of its quality or freshness.

Production of Ginger Flour

A variation on the procedure reported by Gernah and Sengev (2011) was used to make ginger powder. The rhizomes were broken up into smaller pieces and then ground into a fine powder. After being stored at room temperature, the dried rhizome samples were dry-milled and sieved using a 75-micron aperture sieve to eliminate big particles and produce fine flour.

Formulation of Complementary Foods

Soybean, millet, sorghum, crayfish, and ginger flours were painstakingly combined to provide consistent dietary supplements. The following proportions were used for blending:
A - 50% soybean, 30% millet, 20% sorghum

B - 20% soybean, 25% millet, 40% sorghum, 10% crayfish, 5% ginger

C - 40% soybean, 20% millet, 25% sorghum, 10% crayfish, 5% ginger

D - 25% soybean, 40% millet, 20% sorghum, 10% crayfish, 5% ginger
E - 15% soybean, 20% millet, 50% sorghum, 10% crayfish, 5% ginger

To achieve a thorough integration of the ingredients, a rotary mixer (Philips type HR 1500/A, Holland) was employed. This mixing process ensured that the complementary food formulations were uniformly blended.
After mixing, the resulting complementary food formulations were individually packaged in airtight plastic containers to maintain their freshness and quality. These containers were sealed to prevent air and moisture from compromising the products. The packaged complementary foods were stored at ambient temperature until further analysis.

Results

Table1. Proximate Composition of Complementary Foods Samples Produced

Samples	Moisture (%)	Fat (%)	Protein (%)	Fibre (%)	Ash (%)	Carbohydrate (%)
A	10.12±0.13^{a}	1.08±0.06^{b}	9.58±0.07^{b}	4.11±0.05^{a}	2.56±0.03^{a}	72.54±0.08^{a}
B	10.19±0.28^{a}	2.47±0.02^{a}	12.15±0.04^{b}	5.85±0.42^{b}	3.13±0.02^{a}	66.23±0.15^{a}
C	9.49±0.49^{a}	2.60±0.03^{a}	14.26±0.08^{a}	5.92±0.04^{b}	2.19±0.04^{a}	64.34±0.28^{a}
D	8.58±0.03^{b}	2.79±0.01^{a}	15.90±0.01^{b}	6.14±0.01^{a}	3.55±0.08^{a}	62.75±0.51^{a}
E	8.55±0.32^{b}	2.87±0.05^{a}	17.12±0.04^{a}	6.83±0.01^{a}	3.62±0.03^{a}	60.99±0.05^{b}

Value of triplicate mean ± standard deviation determination with the significant different in ($p<0.05$). Samples with different superscripts within the same column were significantly different($p<0.05$).

KEY:
Sample A (control) = 50% soy bean30% sorghum and20% millet flour
Sample B = 20% sorghum 25% millet 40% soy bean 10% crayfish and 5%ginger flour
Sample C = 40% sorghum 20% millet 25% soy bean 10% crayfish 5% ginger flour
Sample D = 25% sorghum 40% millet 20% soy bean 10% crayfish 5%ginger flour
Sample E = 15% sorghum 20% millet 50% soy bean 10% crayfish 5%ginger flour

Discussion

Samples of complementary foods blended with sorghum, millet, crayfish, soybeans, and ginger are shown in table 1, along with their approximate content. Moisture, fat, protein, fiber, and carbohydrate content were shown to vary significantly ($p<0.05$) amongst the complimentary food samples. The samples had moisture levels between 8.55 and 10.19 %. Sample E (15% sorghum 20% millet 50% soy bean 10% crayfish 5% ginger flour) had the lowest moisture content, whereas Sample B (20% sorghum 25% millet 40% soybean 10% crayfish 5% ginger flour) had the highest. These results are consistent with the 8.68 to 8.90% moisture content found in millet-based Ogi that was replaced with plantain and Cray fish (Shalem et al., 2019).

The blends' many advantages stem from their low residual moisture content. For starters, it helps keep the blends fresher for longer by inhibiting microbial development. Many foods may be evaluated for their water activity based on their moisture content. Also, the samples' high moisture content may have reduced the calorie and nutritional densities of the supplementary meals.

The protein composition of the supplementary meal samples ranged from 9.58 percent to 17.12 percent. The lowest protein level was found in sample A, which was prepared with 50% soy bean, 30% sorghum, and 20% millet flour, while the greatest protein content was found in sample E, which was created with 15% sorghum, 20% millet, 50% soy bean, 10% crayfish, and 5% ginger flour. Crayfish and ginger flour, both of which are high in protein, likely account for some of the observed difference in protein content values relative to the controls. When compared to the protein content of maize-tiger nut fortified weaning diets, which was reported by Wakil and Ola (2018) to vary from 7.95 to 13.98%, the protein level of the supplementary food samples reported in this research is greater. Protein is crucial for young children's tissue repair, development, and growth. Possible causes for the discrepancy in protein content between the supplementary meal developed in this research and that developed by Akinola et al., (2014) include discrepancies in the types of crops used and the proportions of those crops used in their development. The Recommended Dietary Allowance (RDA) for protein in newborns up to 1 year old is 13-14g/day, as outlined by the FAO/WHO in 2002. Samples C, D, and E, each produced with 20%, 25%, and 50% soybean, were analyzed for their protein concentrations.

The low cost and high nutritional value of legumes have made them a popular addition to diets across the world (Ukegbu & Anyika, 2012). Ibeanu (2009) stated that the nutritional value of complementary meals given to young infants in impoverished nations might be improved via the use of complementation.

There was also a wide range in the amount of fat included in the supplemental foods we tried, from 1.08 percent to 3.28 percent. Sample E had the most fat compared to the other samples, whereas sample A had the least. Soybeans and other legumes are known to have a high oil content (Ukegbu & Anyika, 2012), hence the increased fat level in sample E is in line with prior results.

When compared to the fat level of samples of complementary meals prepared from maize-based complementary foods supplemented with black bean and crayfish flour, which was reported to vary from 2.35 to 5.17% (Okoye &Ene, 2018), the fat content achieved in this research is comparatively low. This research found that the fat level of these meals was less than the FAO/WHO-recommended 10% for supplementary foods. Because of its high energy density and ability to facilitate the absorption of fat-soluble vitamins, fat is an essential component of the diets of newborns and young children. Furthermore, it provides omega-3 and omega-6 polyunsaturated fatty acids (PUFAs), which are critical for healthy brain and nervous system development in newborns and toddlers (Igyor et al., 2011).

The crude fiber content of the samples ranged from 4.11 percent to 6.83 percent. In comparison to the control sample of 50% soybean, 30% sorghum, and 20% millet flour, the fiber content in Sample E was the greatest. The fiber content of the dietary supplement went increased when it was formulated with soybean and Cray fish flour.

.The crude fiber level identified in maize-based supplementary meals supplemented with black bean and crayfish flour was reported to be between 2.35% and 4.05% (Okoye & Ene, 2018), although the fiber content detected in this research for the samples is higher. Fiber does not generate energy directly, but it is essential for the body because it helps the body absorb nitrogen and certain micronutrients (Michaelsen et al., 2000).

Samples B through E had crude fiber concentrations that were within the optimal range for diets (not more than 5g dietary fiber per 100g dry matter; FAO/WHO, 2014; good for the gut and the heart). In addition to aiding in the regulation of blood glucose and cholesterol levels, fiber also inhibits the absorption of glucose. In addition, regular bowel movements improve safety, facilitate the elimination of waste products, and have an indirect effect on weight control.

Sample E had the greatest ash concentration, at 2.19 percent, whereas sample C, a blend of 40% sorghum, 20% millet, 25% soy bean, 10% crayfish, and 5% ginger flour, had the lowest at 3.62 percent. Fusuan et al., (2017) suggest using the ash level of a food item as an indicator of the meal's mineral contents. This study's findings on ash content are higher than those published by Barber et al., (2017) for supplemental foods made from fermented maize, soybean, and carrot flours. A food's ash content may be used as a proxy for its mineral make-up. So, if there are more minerals in the diet, the ash content will be higher.

There was a wide variation in carbohydrate content, from 60.99 to 72.54%. Sample A (50% soy bean30% sorghumand20% millet flour) had the highest and Sample E (15% sorghum20% millet50% soy bean10% crayfish5% ginger flour) had the lowest carbohydrate content. All of the substituted samples had carbohydrate significantly less content than the control sample A, which is within the range of carbohydrate content of maize-based complementary foods supplemented with black bean and crayfish flour with the value of 65.34 to 78.08% as reported by (Okoye &Ene, 2018).

Due to their high carbohydrate content, the study's samples are nutritionally desirable since they can fuel the physical and physiological activities of developing infants (Ibironke et al., 2004). Furthermore, the nutritional profiles of supplementary meals were greatly enhanced by replacing maize with malted millet, malted sorghum, soybean, crayfish, and ginger flour. Overall, the nutritional content of the supplemental meals was improved due to the addition of these components.

Conclusion

This study concluded that complementary foods could be produced from multi- mixes for households who depend on locally formulated diets to feed infant and young ones. This study therefore recommend use of sorghum, millet , soybean and crayfish that are high in protein and other essential nutrient to meet the nutritional needs of infants and young children as it could be a panacea to promote dietary diversity and reduce prevalence of under-five malnutrition in Nigeria.

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